



**Honours Project (CCIS)**

# **INTERIM REPORT**

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**“Except where explicitly stated, all work in this report, is my own original work and has not been submitted elsewhere in fulfilment of the requirement of this or any other award”**

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## 1.0 Project Introduction

### 1.1 Background Overview

Designing for serious games requires the knowledge of current teaching methods that inspire motivation and critical thinking. Many games are inadequate of applying psychological principles that link game design, psychology and education.

#### 1.1.1 Serious Games in education & Game Based Learning

Gros (2007) describes that games are likely to have an impact on the player's outlook on situations and can leave long term changes and can be used to learn new information. "83%" of Master and Graduate student participants would apply Digital Game Based Learning to their teaching methods after partaking in a workshop (Charlier & De Fraine, 2012). This indicates a high number of future teachers from the workshop would consider adapting a game-based learning approach to their teaching, making it a significant method of learning. The application of Game based learning in a teaching environment was successful in teaching students and more likely to increase motivation (Nadolny et al., 2017). This suggests that when presented with a game to learn from, students are more engaged by showing more motivation to complete a task when applied in a game-based setting. A study piloted by Kilsch et al. (2012) indicated that teaching school students about inhalants was successful when teaching using a digital game. This illustrates that the use of a game in a learning environment can be beneficial in teaching a topic as it can increase motivation to learn and the engagement of students.

Westera's (2019) conclusions mention that the use of serious games as a tool for learning is still underutilised as traditional means of learning are still common practice. Although a study carried out by Ameerbakhsh et al. (2019) explored the use of serious games in teaching students about marine ecology against a professional presentation using an assigned lecturer in the field. The conclusions indicated that the students benefited when the lecturer provided an in-depth presentation of the game was most effective in their understanding of the subject matter.

#### 1.1.2 Current issues with education games

Torrente et al. (2009) states that games that the benefits of using games in an educational environment remains inconclusive to their overall effectiveness and classrooms still lack appropriate preparation time to set up the games in addition to having the required technology to run them. Barko & Sadler (2013) indicate the issue with current educational games and how they do not engage with the player and simply show the topic area with answers and no further interactions. Moura (2015) also states that educational games must be engaging to immerse the player and attract players to continue learning, stimulating their interest in a topic area whilst providing constant evaluation techniques. Trevino et al. (2016) developed a game for contrasting the learning of Optometry using an educational game combined with lectures. The game that was developed was a simple trivia-based game, with question cards and a board to interact with. The issue surrounding the game is that it was only a memory test based on the players own learning and does not teach them the subject matter in an interactive form. Similarly, Rondon et al. (2013) solely used the quiz section of the game they had created to teach anatomy despite having incorporated mechanics that supported learning. The use of the quiz itself still only required current knowledge in a topic and did not engage the learner in

teaching them using gameplay as a purposeful interactive way to present information. Amory (2007) suggested that educational games need to give the players space to actively learn, where they are free to explore and apply their understanding to the challenges presented.

### 1.1.3 Game Design Frameworks

An adapted design framework for the Digital Game Based Learning cycle combines forms of motivation and usability to develop an environment suitable for teaching a subject in an effective manner (Nadolny et al., 2017). A model for game development was also developed by Stark (2014) that encouraged learning in students and could be applied to develop games that set goal orientation and meaningful interactions with information. A triadic model was discussed by Rooney (2012) which highlights the three key aspects of modelling a game for learning. Using these frameworks as examples of tested methods can assist in the development of an education-based game as each one was used to teach a topic whilst simultaneously maintain students' interest in obtaining knowledge. The MDA framework is also applicable as it explores the Mechanics, Dynamics and Aesthetics of a game Umar Ruhi (2015) and look at gamification as a factor in learning. There are many frameworks used to give a greater understanding to developing games, some frameworks share the same design philosophies and outcomes highlighting the shared importance of certain elements.

Being able to engage with a student's behavioural outlook on learning depends on their emotional state of mind (Schindler et al., 2017). Including ongoing feedback and ways to invite player to explore their own thoughts and ways of thinking is encouraged when engaging with educational games (Nachimuthu & Vijayakumari, 2011). This learning is further secured by allowing the players to actively participate in their learning and develop greater understanding than through traditional means (Corredor, Gaydos & Squire, 2014). Gamification of existing design frames can also provide a learning tool to better enhance engagement (Mora et al., 2017). Suggesting this makes the learning of new information as a more interactive way which motivates the player to retain new facts and apply them in a more dynamic way.

Yussof et al. (2018) developed a set of design principles for education games, their three main points were; develop player interest in the game, ensure it is emotionally engaging and contain motivational proceedings. Supporting the requirement that the game is appealing to the target audience and meets the expectations of the learner.

## 1.2 Research Question

**How can the application of a cognitive design framework facilitate game designers when developing educational games?**

### 1.2.1 Hypothesis

The development of an education-based game using a framework will assist in creating an environment suitable for engaging with learners and provide an opportunity to connect knowledge-based practices with game design.

### 1.2.2 Project Type

The project will involve a HCI evaluation approach to analyse the game, giving feedback on how effective the adopted framework was in designing the game and evaluate the inclusion of design principles to produce a greater understanding between educators and game designers so that educational games are created that are inclusive of the proper design philosophies and effective teaching during the gameplay.

### 1.2.3 Project Aim

The aim of the project is to reduce the divergences between educators and game designers to develop an effective educational game that combines both forms of design and teaching to create a learning environment that will motivate the player to learn about a topic and actively produce challenges for them that will require their skills in learning.

### 1.2.4 Justification

Teaching a core topic should be effective when using a game and designers need to understand the process for which subjects are taught. Teachers are also required to know how to create a game that efficiently teaches a subject and does not rely on memorability as the core reason for success. The combination of a topic and game development must be combined and use a framework to ensure that a compelling solution is created, constantly engaging with the player and enhancing their overall learning experience.

### 1.2.5 Project Outline

#### **Research the CBGD Framework and compare with others**

The CBGD Framework Starks (2014) will be broken down, with select elements being used directly to help in the development of the educational game. Additionally, other frameworks will be assessed to analyse if there are elements that can be incorporated into the chosen framework.

#### **Analyse the use of education games in learning**

An analysis on educational games usage in learning to allow for evaluation and to identify areas of importance that a framework can improve when designing games suitable for teaching a topic.

#### **Research relevant design principles**

Research design principles that will support the use of a framework and compliment the game design with the relevant ways to incorporate them, applying a psychological approach to designing the core fundamentals of the game and providing useful insight to various techniques that can be applied.

#### **Obtain a topic for the development of the game**

A relevant topic for the educational game to be designed around will be required to facilitate the relevant information and correct facts to allow for the learning of the subject and use relevant design principles that will complement the overall design. This will aid in reducing the overall scope of the game and set clear priorities for the development cycle.

#### **Develop an educational game with the use of a core framework**

The educational game will be developed using a framework designed to combine the learnability through teaching and design principles that inspire motivation and engagement within the player. A relevant target audience will also have to be defined to develop the game for, so the style and choices reflect the demographic.

#### **Analyse the effectiveness of the game**

The game will be tested with students to gather feedback on the game and analyse the deployment of the framework and design principles in developing an engaging experience that demonstrates effectively the combination of teaching and educational games.

## 2.0 Literature Review

### 2.1 Analyse Cognitive Behavioral Game Design Frameworks

A framework developed by Starks (2014) (Figure 1) was used to inspire game development that encouraged growth and change in a user's perception of learning. The framework that looks at Cognitive Behavioral Game Design (CBGD) prioritises the need to put the users own cognitive ability first and apply design mechanics that best suit the method of learning, this can include elements such as graphics, audio and use of recall. This framework will be adopted and in order to assist in the of design of an educational game. Key aspects of multiple intelligence elements will be chosen in the development process of the game. Graphics, Music, humour and personal reflection will be the main areas of interest when developing the game. The main steps of the enjoyment process will be; player engagement, challenge and mastery to allow the player to interact successfully and have a meaningful experience when playing the game.

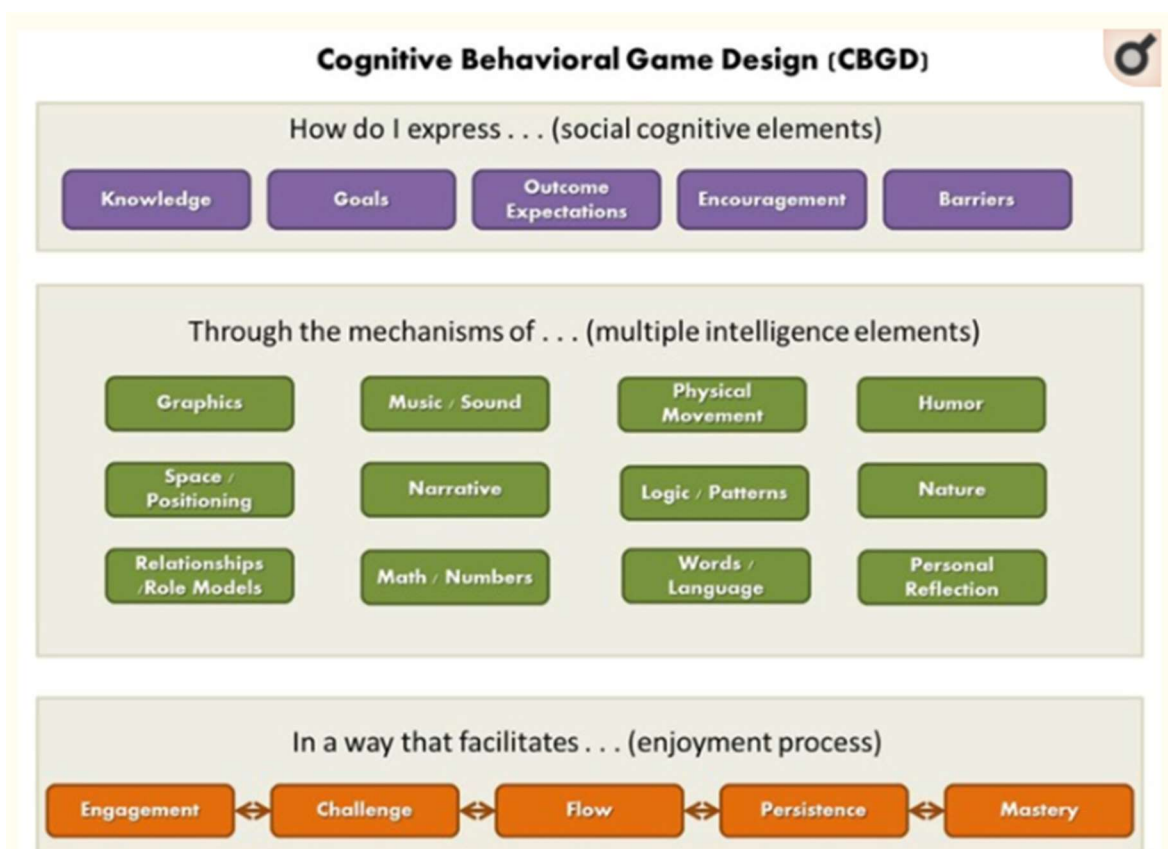


Figure 1 Cognitive Behavioral Game Design Framework (CBGD), Starks (2014)

The CBGD Framework was developed to aid in the design of educational games and combine meaningful design principles with the proper educational background to deliver an authentic learning experience.

Carvalho et al. (2015) presented the Activity Theory-Based Model of Serious Games (Figure 2) that highlight the three key aspects of developing a serious game. Each section has its own motives, Gaming Activity influences the need to engage and gain enjoyment. Learning Activity focuses on the subject at hand and what topic is to be looked at and studied. Instructional Activity is used to grasp the attention of the intended user to enhance the learnability of a topic.



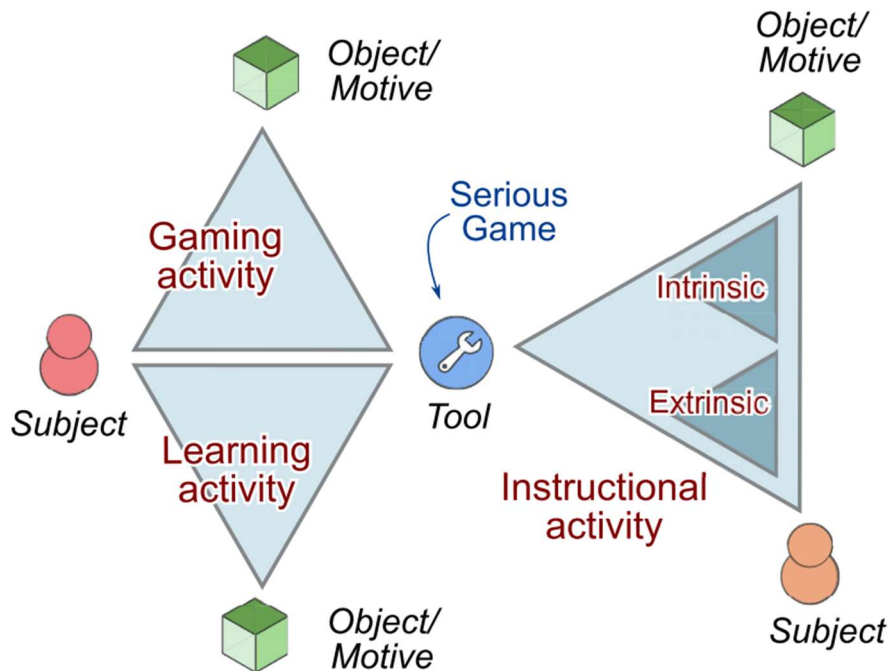


Figure 2 Activity Theory-Based Model of Serious Games, Carvalho et al. (2015)

However, this model relies on an educator having knowledge in a topic and provides it whilst the gameplay is taking place or upon completion. “Extrinsic Activity” is dependent on who is teaching with the game and the environment that is being used in Carvalho et al. (2015). Since the design process will not have access to educators, the model would be harder to adopt when developing the game.

## 2.2 CBGD Framework Social Cognitive Element Analysis

### 2.2.1 CBGD Framework- Knowledge

Knowledge implies the purpose of what the game is trying to teach depending on the topic area and the various techniques to effectively communicate to the player so that the learning of new information takes place (Starks, 2014). Coleman & Money (2019) mention that a task should remain challenging to the player but still allow for them to interact successfully with it or there is a risk that the player will lose interest as a result for a task being beyond their capacity of learning. Bayart et al. (2014) supports the theory that knowledge is acquired through practice and applying it to complete tasks. Therefore, the challenges that represent the players current ability should be reflected in the game design and gradually increase the difficulty as the player becomes more proficient in solving tasks.

### 2.2.2 CBGD Framework- Goals

Goals relate to what can be achieved through completing activities during the gameplay and knowledge acquisition that can be applied into the real world as well or other intentions that the game was developed to emulate the importance of (Starks, 2014).

Nadonly et al. (2017) explored a model for Game Based Learning (Figure 4) that involves the use of learning goals that amalgamate with gameplay objectives to produce learning outcomes that inspire the acquisition of knowledge. The model itself can be beneficial when compared with the Cognitive Behavioral Game Design Framework and provide insight to a system that promotes the learning of a new topic with constant recall and application of the newly learned subject.

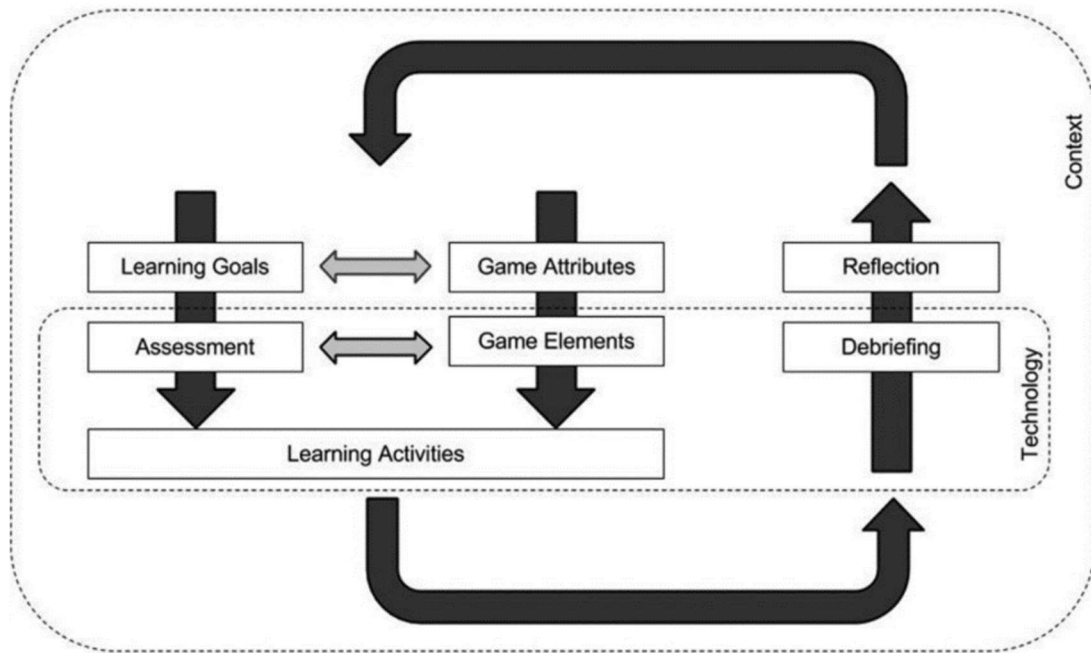


Figure 4 Game Based Learning Cycle Model, Nadonly et al. (2017)

The model focuses on how to develop games which encourage the player to learn and set achievable objectives. Use of games that insight iterative learning can help strive players towards achieving goals set out through the intended design (Mavromihales Mike, Holmes & Racasan Radu, 2019). This feeds into the goals set for games and the usefulness they have when applied in a game setting to enhance the learning experience. Though this theoretical framework will not be applied, it highlights the necessity to have goals in an educational game.

### 2.2.3 CBGD Framework- Outcome Expectations & Encouragement

Encouragement comes in the form of commending the player for doing a good job and completing tasks correctly to promote further successful learning and accomplishments (Starks, 2014). This can relate to types of motivation that encourage players to continue to learn. Man-ki, Surng-Gahb & Tae-Yong (2011) explored an exponential system for the player gaining a reward and broke it down into three elements “level-based progression, skill-based progression and free form advancement”. They state that most games now have an experience points-based system that rewards the player on completion of tasks. This can support the use of a scoring system within the developed

game to add a form of motivation for the player to grasp towards. Jabbar and Felicia (2015) developed a diagram that influences the intake and use of knowledge (Figure 3).

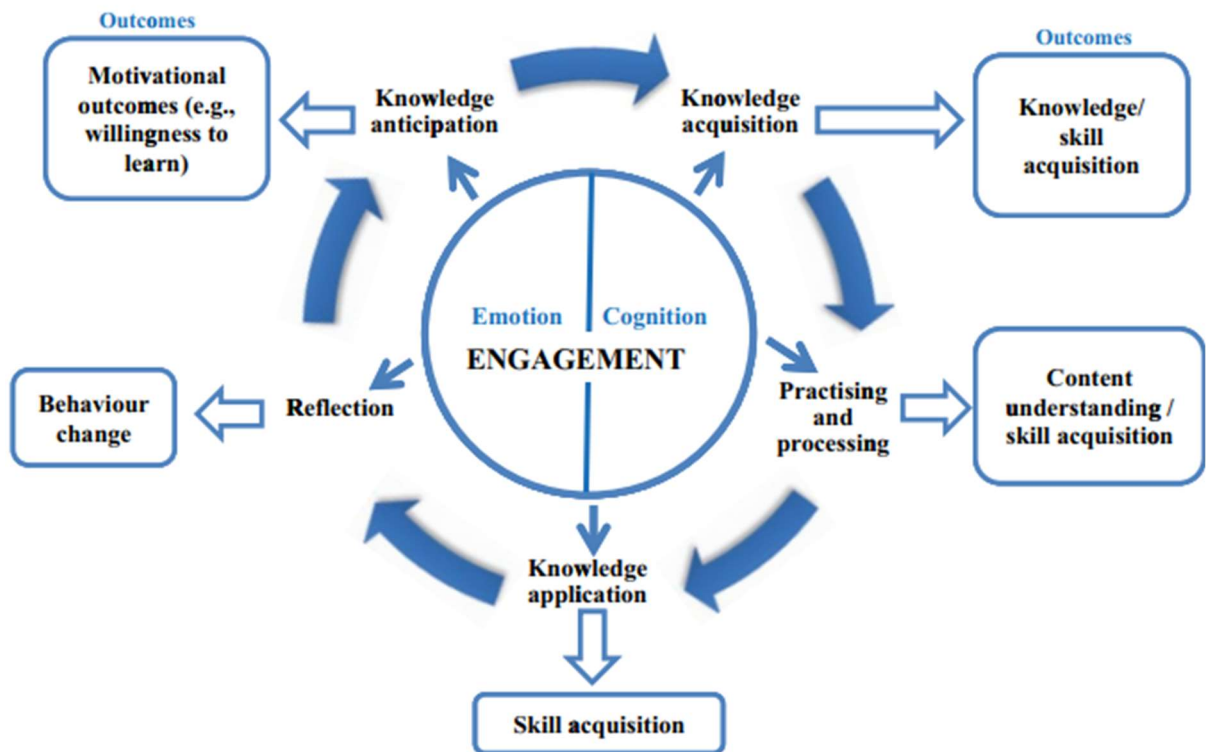


Figure 3 Engagement Model Jabbar Felicia (2015)

The model indicates the key aspects of receiving, understanding and using knowledge based on the intrigue centred around a topic has when maintaining an emotional connection with the learner that continues to motivate and strive towards goals.

#### 2.2.4 CBGD Framework- Barriers

Starks (2014) states that barriers are in place to prevent players from going off course and losing track of what the main objectives of the game is. This is usually a design decision in place to prevent players from wondering off and entering places that were not designed for them to be in. In addition, this can reflect barriers in the real world and inspire players to overcome hurdles that could improve them.

### 2.3 CBGD Enjoyment Process

Three main elements will be used from Starks' (2014) framework to assist in the design process of the game (Table 1).

Elements	Reasoning
Engagement	Engagement requires the player to actively participate during gameplay and maintains their interest when completing a challenge. It is important to provide visuals and ongoing assistance so that a player is stimulated during the experience.
Challenge	Challenge provides the player with meaningful tasks that requires active participation and problem-solving skills. The challenges must be within the capability of the player as to reduce their frustration and avoid making the experience less engaging.
Mastery	Mastery allows the player to complete the game with an improved understanding of the topic and can then apply it both out with and within the game context, effectively having successfully learned the skills needed to overcome challenges.

Table 1 CBGD Enjoyment process Starks (2014)

The game should successfully deploy these processes to apply better cohesion with the framework and should produce the requirements for the player to support the use of Multiple Intelligence principles and provide meaningfulness to each cognitive element, providing an opportunity to express the importance of using a framework to design educational games that deliver an experience to the player that increases motivation of learning and actively teaches skills. Flow has been removed as it can be challenging to have a game that successfully allows the player to immerse themselves, since the nature of the game is educational, flow may be broken when having to solve problems that involve the player actively trying to solve questions relating to the topic.

## 2.4 Game Design Principles

Houser & Deloach (1998) analysed Donald Norman's design principles by breaking down the relevant steps to developing a game (Table 2).

Principles	Description
"Attract Mode"	Players should be able to interact with ease and at a fast pace.
"Clearly Stated Goals"	Players always know what is required for them to achieve success
"Brief Instructions"	The player should not be overloaded with information to begin with, only the necessary elements.
"Transparency"	Players will not be affected by elements out with their control.
"Performance Coaching"	The player will be provided optional help throughout the gameplay that they can decide on using.
"Training Wheels"	The player should accomplish tasks from the when they initiate play and learn more as they continue to understand and progress further.
"Consistent Feedback"	Players will receive constant evaluation for their actions to maintain motivation throughout the game.

Table 2 Houser & Deloach (1998) 'Seven Principles of Effective Design'

These design principles adapt well to the CBGD Framework Starks (2014) as they share elements that enhance the overall experience the player receives when interacting with the game and reflect the requirement to emphasise the importance of understanding what motivate a player to learn and interact, maintaining constant engagement.

Rosario & Widmeyer (2009) investigated the use of design principles based on other findings for teaching using games, only specific principles are relevant to what is required to develop the educational game using the CBGD framework Starks (2014) (Table 3).

Chosen Principles	Description
“Multiple Routes”	Players can tackle situations in more than one way, requiring further thought processes and engagement.
“Practice”	Players are free to practice in an area that maintains enthusiasm.
“Regime of Competence”	Players should continually face tests that push their understanding, but not excessively.
“Engaging”	The game should actively engage with the player and have thematic elements that retains their attention.
“Achievement”	Players will actively receive feedback based on their performance to apply continuous motivation on how well they are doing.

Table 3 Selected principles from Rosario & Widmeyer (2009) ‘Design Principles’

These sets of principles have overlapping examples which help to justify the use of them when developing a game using the CBGD framework Starks (2014) to develop an educational game that actively engages with the user to set clear goals during gameplay and highlight the key aspects that must be included to develop an engaging experience that is meaningful to the player, requiring them to actively learn both from completing activities to progress further and learn in failure.

## 2.5 Serious Games in learning

Mechanics that include the enhancement of learning is adapted to suitably compliment the game design, which allows for greater user engagement. The design of serious games can be broken down into three key structures “Domain Content, Game, and Learning Theories” (Mestadi et al., 2018). These key sections are used to define the development of a serious game that draws upon each aspect and links them to have a balanced design that integrates the ability to learn through the aspect of a game, additionally having the fundamental benefits of developing an understanding in a subject. The design of serious games focuses around developing base knowledge during gameplay and challenging the player to use their intuition to solve tasks that are given to them as they play (Su, Chen & Fan, 2013). The evaluation strategies carried out on the serious games reflects the overall usefulness of them when played and offers a chance to highlight missing elements that could enhance the overall game design. The use of serious games was also supported in a classroom environment to educate pupils

about a topic (Klisch et al., 2012). The results showed an overall mean score of “58.8%” though this was due to the nature of the time spent on the subject and reduction in input from a teacher to further elaborate. This emphasises the relevance of using games as a teaching method as it can provide an interactive experience that guides users to apply their newly found knowledge and motivate them to gain a higher understanding to benefit more when playing a game. Lunn et al. (2016) argues that serious games need to be more capable of fully teaching a subject, as the current state of serious games only initially gets the initial knowledge across before more traditional methods are required to fully develop an understanding of a learner. Vlachopoulos & Makri (2017) state that educational games are still seen as an additional teaching tool that aids in learning. This indicates that there is still a disconnect between games being used formally as an educational tool. Therefore, the application of the CBGD framework Starks (2014) should facilitate the overall game design when developing an educational game and implement factors that promote learning in a digital game environment, benefiting the players learning style and sustaining and engaging experience that utilises the knowledge of educators.

## 2.6 Multiple Intelligences

Multiple Intelligence (MI) as described by Howard Gardner by Kelly (2008). It focuses on the learner and developing a suitable knowledge-based deliverable for them (Kelly, 2008). MI breaks down abilities into subcategories necessary to a single person. Each “intelligence” depends on the individual's ability in a field and can be categorised into one of the multiple suggested categories (McMahon, Rose & Parks, 2004). An individual share many different traits in intelligence and cannot be locked into a single category and helps in deciphering new knowledge (Prasad, 2016). Identifying that every person's perception is different and that it is challenging to model after a large variety in learning. Maftoon & Sarem (2012) state that intelligence can be broken down into three main elements; it can be learned from experience, it can evolve as a person grows psychologically and individual experiences result in various learning behaviours. There are multiple ways to initiate learning in an individual, with many paths that lead to the same conclusion and is dependent on the mindset that a person has, meaning that different approaches will be taken depending on a person's background (Leshkovska & Spaseva, 2016). An analysis of MI indicates that every individual think differently and presents a challenge when trying to adapt a problem to suit their inner thinking and processing capabilities as some will tackle it with a more creative approach and others have a more analytical view. These concepts of MI were broken down and applied in Starks’ (2014) Framework to support each requirement that reflects an individual (Figure 1), the elements presented involve ways in which to increase player engagement and actively support multiple styles of learning that can be applied to the game to suit multiple users. The application of MI adheres to a psychological approach when designing for players using the CBGD Framework Starks (2014) as it helps to produce an engaging environment that is adaptable to the numerous requirements of each player, providing the necessary resources that actively promote learning and expanding a player’s knowledge.



## 2.7 Existing Educational Games

A list of educational games examples with analysis of the benefits and issues surrounding their design (Table 4).

Game	Benefits	Issues
1066 (PRELOADED, 2009)	<ul style="list-style-type: none"> <li>• Fun interactive way to learn about the battle of (1066)</li> <li>• Elements of humour to aid in learning of common battle phrases</li> <li>• Use of cutscenes that provide a way to visually engage the player and deliver information.</li> </ul>	<ul style="list-style-type: none"> <li>• Players may only remember the gameplay rather than the information on the battle.</li> </ul>
Minecraft Education Edition (Mojang AB, 2016)	<ul style="list-style-type: none"> <li>• Provides an interactive learning environment for the player.</li> <li>• Adaptable to fit requirements of the user for teaching.</li> <li>• Highly versatile world that is open to applying skills in a safe environment.</li> </ul>	<ul style="list-style-type: none"> <li>• Teachers need an existing knowledge to adapt the game to suit their needs.</li> <li>• Can be complex to those who do not know enough about games.</li> </ul>
Fact Monster (Sandbox Networks, 2019)	<ul style="list-style-type: none"> <li>• Applies on knowledge already learned in a topic.</li> <li>• Uses already studied maths skills.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires memorability to complete tasks.</li> <li>• No progressive nature to continue motivational practices of engagement.</li> <li>• No development of understanding if answers are wrong.</li> <li>• Time constraints are the only form of challenge and the task is to correctly answer as many as possible.</li> </ul>

Table 4 Examples of Educational Games

These examples of existing educational games provide an insight into what helps to create a good educational game and what elements must be included to ensure an interesting experience to the player. Fact Monster (Sandbox Networks, 2019) presents issues of a game that does not provide any motivational gameplay other than to challenge the player to correctly answer as many questions as possible in a time frame. Minecraft Education Edition (Mojang AB, 2016)



provides an open learning environment, however emphasis on the educator having to study the game first before being able to apply lessons for the player to study provides issues that the game is not readily available to play when activated (Kuhn, 2018). This supports the aid of the CBGD framework Starks (2014) in the development process of games as it utilises the important factors of designing an education game that broadens the player's understanding of a topic using relevant design principles and Multiple Intelligence elements to involve the various types of learning processes found in individuals.

## 2.8 Game Topic

The game topic will be centred around mathematical problems that school pupils will face as it allows for a variety of creative techniques to be applied using the CBGD Framework Starks (2014) and design principles so that an engaging experience will be developed with an appropriate environment that supplements the use of motivational techniques and aids in learning. Since mathematics is a foundational skill taught in schools, it suggests that it would be appropriate to design a game that promotes encouragement to successfully navigate mathematical problems that require complex solving and active participation to achieve goals set within the game.

## 2.9 Technology review

GameMaker Studio 2 YoYo Games (1999) will be used develop the educational game as it is suitable for making 2D games beneficial for creating an educational game and allows for progressive iterations to be formed with easily adjustable parameters. The software allows for a lot of customisation when designing and provides tools which enable users to develop accordingly. The software enables game design and several resources to assist in the development process allowing for more complex gameplay sequences to occur. Since the game is focused on developing mathematical skills the answers will remain binary, narrowing down the scope of the game so that a greater amount of time can be spent on the visuals, sounds and interactivity of the game. Audio and artwork will be required in the development of the game to have sound and visual feedback throughout the gameplay and to provide an appropriate setting for the target audience. For audio, royalty free music from Freesound (Bram de Jong & Freesound Team, 2005) will be considered for its library of different sound files. Artwork will be supplied from Royalty free sources, or if necessary, from Piskel (Piskel, 2013) as Pixel Sprites can be created using the software including animations that can develop a cartoon style of game.

### 3.0 Methods

The purpose of this project is combine the effectiveness of being taught a topic with the relevant design principles which are formed on psychological understandings in how to best design a suitable game that promotes an environment where the learner is faced with challenges that actively uses their knowledge to unlock further tasks and rewards in place that emphasise the importance of their learning. Using the CBGD Framework Starks (2014), the games development cycle and evaluation will provide insight into the overall success of the design and reflect the necessity to apply a framework to develop well executed educational games. These methods will support the requirement of a framework for developing educational games and breakdown the necessary areas that must be utilised in the design cycle.

#### 3.1 Pilot Focus Group

A focus group of game designers will be conducted to generate ideas based around the core topic of the game to generate ideas on what elements will be required to be the fundamental basis of the game to start development. The suggestions made by peers will be analysed against the CBGD Framework Starks (2014) to highlight any missing elements that the framework includes to support the gaps that game designers have when developing an educational game, supporting the importance of applying it during the development process.

#### 3.2 Adopt the CBGD Framework for the development of the game

The CBDG framework Starks (2014) will be adopted to help in the creation of the education-based game to give context and reasoning as to why certain design decisions are made. Since the framework retains the relevant elements that enhance the design process and include areas designed to promote learning using an educational game, adopting the framework will provide a focus point to refer to when deciding on the necessary steps

##### 3.2.1 Apply Design Principles to the framework

Design principles stated by Houser & Deloach (1998) and Rosario & Widmeyer (2009) will be used in the development process to assist in the reasoning with game design choices and reflect the requirement to have elements in place that complement the gameplay, enhancing the experience the player will receive during gameplay encouraging motivational practices and drive towards achieving goals.

#### 3.3 Build Education Game using CBGD Framework

An education game will be developed to show and teach participants about mathematics using GameMaker Studio 2 YoYo Games (1999) as the source for developing a 2D Game as it provides useful tutorials and is best equipped to make 2D Games. The topic will be on mathematics as it is a relevant field in learning and can be adapted into a game using the framework developed by Starks (2014).

### 3.4 Develop Test and Data Capturing techniques

A test questionnaire will be developed along with the relevant capturing software to collect test results and calculate the averages to explore the effectiveness of the education game. Questionnaires will provide an insight to the overall quality to the game and evaluate the principles chosen to reflect the gameplay presented, and the adaptability of the topic being taught through the challenges involved during gameplay. The questionnaires will be digital based using Google Forms (Google LLC, 2008) for ease of access and will contain a mixture of qualitative and quantitative questions to gather as much data that will be broken down to evaluate the use of the model, design principles and general presentation of the game. Yáñez-Gómez, Cascado-Caballero & José-Luis Sevillano (2017) provides a list of relevant literature that can be beneficial to developing a subsequent questionnaire to best capture results and give in-depth analysis of the game.

### 3.5 Recruit Participants to analyse the game

Participants will be recruited from the university to play the game and analyse the experience by filling out the relevant questionnaires to gather feedback on the effectiveness of the game and to further account for improvements that can be made with subsequent updates and iterations. Primarily designers will be used to evaluate game as they have better critical analyse skills when playing games and are more experienced in providing feedback regarding the effectiveness of the gameplay and visuals in place to promote learning. A lab will be set up with the game ready to be deployed to immediately allow players to start playing.

### 3.6 Testing and Gathering Results

Testing will take place once the core game is complete, when the players complete the game given a questionnaire will be filled out to critically evaluate the framework and the principles put in place to design the game based upon the feedback provided from players. The post-test questionnaire will take place immediately upon completion of the game to reflect on the gameplay they had just partaken in, these questionnaires will then be gathered up for analysis on Google Forms (Google LLC, 2008). Additional observations during gameplay will also be noted if relevant to the overall game design.

### 3.7 Analyse captured data and develop conclusions

The information provided from the feedback questionnaires will provide insight as to the effectiveness of the game's deployment on the chosen platform and will provide insight if it has successfully supported the criteria suggested from the CBGD Framework Starks (2014) and design principles (Houser & Deloach, 1999; Rosario & Widmeyer, 2009). With the broken-down analysis, conclusions can be provided to support the use of a framework in developing educational games and reflect the missing elements required by designers to create a game that benefits the player in their learning.

### 3.8 Potential Ethical Issues

Potential ethical issues that surround testing involves providing confidentiality with the data gathered from the questionnaires. To ensure that no ethical issues are encountered, the tester will be required to sign a form accepting that they comply to having their results strictly used for research purposes and that it will remain strictly confidential. They will also be allowed to leave the session at any point if they no longer wish to participate and their results redacted if they do not want them to be used.

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